Composite capsule for sealing bottles and similar containers, various processes for making said composite capsule and apparatuses for implementing said processes

BACKGROUND AND PRIOR ART:

The invention relates to a device for sealing bottles or containers, comprising a cap element which has the shape of a closed bottom cup and includes a diaphragm that is stretched perpendicular to the axis of the device, at a suitable distance from the closed bottom, and a peripheral cylinder- or truncated cone-shaped wall which is designed to lie over the end portion of the container opening, which peripheral wall has means for coupling it, by deformation or screw fastening to cooperating radial ridges or external threads of the outer end portion of the container opening, there being further provided seal means interposed between the cup-shaped element and the container opening edge.

In prior art, several types of such caps are known, which are fitted on containers in several different manners.

According to prior art specific techniques, liquid and/or food containers are sealed either by means of screw caps or metal crown caps, or various metal or plastic disks, to be attached to the opening edges, or blind seals, which are held in position by other mechanical devices, like those mentioned above.

Other types of caps, such as thread-on metal caps,

are made of cylindrical capsules to be fitted on the opening in such a manner as to lie over the outer surface of the container end portion at said opening, which end portion has external threads formed thereon, while the capsule is internally threaded by rolling it against said externally threaded end portion.

In jars or the like, other types of cylindrical cup-shaped caps are known, which have inner radial ridges on the free edge of their peripheral wall, which projections form internal thread segments cooperating with external threads formed on the outer surface of the jar wall end portion associated with the opening of the jar.

Plastic caps already have internal threads for cooperation with external threads formed on the end portion of the container at the opening thereof.

In all these embodiments, the sealing effect is obtained thanks to the cap material itself or to sealing disks or rings disposed on the inner face of the cap wall, which is positioned perpendicular to the opening axis.

Furthermore, prior art caps typically have safety means for ensuring maintenance of the closed condition of the container, which act as tamperproof seals for indicating any package tampering attempt.

These means typically consist of end rings extending from the open side of the capsule, which are integrated during manufacture of the cap. In metal caps, bridges to the cup-shaped element, i.e. to the side wall thereof, are provided to form a tear-off

weakened line, requiring a predetermined tearing force.

These end rings typically have internal radial ridges, which may have an annular or discontinuous shape, for engagement behind external radial ridges, such as annular shoulders or the like, formed in the end portions of the openings of containers, particularly bottles.

Both functions of prior art caps may cause drawbacks. First, the use of sealing disks or rings requires a certain number of manual operations for fitting the sealing disk or ring onto the cap, which is a relatively expensive and complex procedure. Also, the use of seals between the cup-shaped element and the container opening does not ensure sterility inside the cap and generates problems in the sterilization of both seals and cup-shaped elements.

Second, tamperproof sealing is obtained by providing that an annular end portion of the side skirt wall of the cap has a tear-off portion, requiring a predetermined tearing force, which is integral with the cap, and that it can be elastically or non-elastically deformed to engage with a radial widened portion of the end of the outer wall of the container opening, which is situated upstream from the threaded portion of said end.

The invention has the object of providing a cap that, by simple and inexpensive arrangements, allows to improve the sealing effect between the cap and the container, simplify the operations required for manufacturing the cap and fitting it on the container,

and reduce the costs associated with the caps and with container closure operations, while improving the hygienic quality of the product.

Further, the invention has the object of obtaining a better tamperproof effect, by effectively preventing any attempt to defeat tamperproof means or to conceal container tampering effects.

All the above with the purpose of reducing cap fabrication costs as compared with prior art caps, and without requiring any change in capping processes currently used in bottling and packaging lines.

SPECIFICATION:

The invention achieves the above purposes by providing a cap as described hereinbefore, wherein the sealing means consist of a diaphragm 2, that is subtended perpendicular to the axis of the cup-shaped element 2, the so-called capsule 3, and completely covers the open side of said cup-shaped element 3, said diaphragm 2 being made of an extensible plastic film.

The extensible diaphragm 2 may be directly secured to the edge of the open side of the capsule 3 or be fitted into the capsule 3 in a retracted position relative to said edge of the opening, i.e. in an intermediate position between the latter and the closed side.

The diaphragm may be secured in several different manners, i.e. either by gluing or by other chemical and/or physical adhesion arrangements.

In accordance with a first embodiment, as shown in Fig. 1, the diaphragm is directly attached to the edge

that surrounds the opening of the cup-shaped element 3 i.e. the capsule. This edge may be advantageously widened to form an enlarged portion or flange, having a wider surface for adhesion to the diaphragm.

The variant of Fig. 3 provides, alternatively or in combination with direct attachment to the edge that surrounds the opening of the cup-shaped element 3, that the diaphragm 2 extends radially beyond said edge and forms an annular peripheral band for attachment to the end portion of the outer cylindrical wall of the cup-shaped element 3 at the open end thereof. Here again, the diaphragm may be secured by gluing and/or other chemical and/or physical adhesion arrangements.

Also, according to this variant, the adhesion of the annular peripheral band of the diaphragm 2 against the outer surface of the cup-shaped element is caused by the natural resiliency of the previously stretched diaphragm 2, i.e. by its ability to shrink thereon. In fact, while the elastomer of the extensible diaphragm 2 has plastic properties, i.e. mutually sliding macromolecules, it is also capable of partly recovering its original structure after being stretched. Particularly, when a diaphragm 2 of the above type is laid over the opening of the capsule, i.e. the rigid cup-shaped element 3, and is simultaneously stretched along the axis thereof, the volume of its material decreases in sections coaxial to the opening as these sections approach said container opening. A surface of revolution is thereby generated, whose generatrix is a paraboloid. Once the longitudinal stresses in the

plastic material are released, the resilient vectors, that are higher along the axes normal to vertical stretching, due to geometric and mechanical reasons, generate an annular shrinking effect parallel to the concentric cross sections of the surface of revolution, thereby causing the annular peripheral band of the diaphragm to crimp the outer edge. This shrinking or crimping effect may achieve very high pressure values, depending on the diaphragm thickness, and is always effective to ensure a tight sealing effect.

At the same time, the diaphragm 2 may be advantageously fitted on the capsule 3 by heating both the diaphragm and the rigid capsule.

In a variant embodiment as shown in Fig. 2, the diaphragm may be disposed on an intermediate plane between the closed side and the open side of the cup-shaped element 3, there being still provided a peripheral band lying over the cylindrical side wall of the cup-shaped element 3, this time on the inner side thereof.

Here again, the diaphragm 2, i.e. the peripheral band thereof may be attached to the inner wall of the cup-shaped element 3 by adhesion, welding and/or any other chemical and/or physical process.

According to an alternative embodiment, the plastic elastomeric diaphragm 2 is fitted on a bushing 11 or a cylindrical ring nut, which is open on both end sides and, according to a first embodiment, as shown in Fig. 4, has such an inside diameter that, when the diaphragm 2 is subtended over the opening of the cup-

shaped element 3, with the annular peripheral band thereof overlapping to a certain extent the outer surface of the peripheral wall of the cup-shaped element 3, the bushing or ring nut 11 lies, thanks to an elastic and/or shape fitting arrangement, over the cup-shaped element 3, along a portion of its axial extension, at the end of the opening of the cup-shaped element 3, thereby compressing the peripheral band of the diaphragm 2 against the outer surface of the wall of the cup-shaped element 3.

In a similar additional variant, as shown in Fig. 5, the ratio of the diameter of the cup-shaped element 3 to the diameter of the bushing or ring nut is such that the bushing 13 lies over the inner surface of the peripheral wall of the cup-shaped element 3, along a certain axial depth, while compressing, by its outer surface, the annular peripheral band of the diaphragm 2 which overlaps the outer surface of the bushing or ring nut 11 against the inner surface of the cylindrical wall of the cup-shaped element 3.

Obviously, the diaphragm may be also subsequently welded or simultaneously glued.

The bushing 11 or 13 or ring nut may have lead-in surfaces, which may consist, if the bushing or ring nut is designed to be force fitted in the cup-shaped element, of a conical or rounded tapering of the insertion end.

In both cases, the bent diaphragm 2 is advantageously embedded in the assembly of the cup-shaped element and the bushing 11 or 13 or ring nut.

According to another variant embodiment, the bushing 11 or ring nut and the cup-shaped element 3 are connected by means of radial ridges of one of the two elements, cooperating with radial recesses of the other part, which radial recesses may be provided originally or formed by deformation by the radial ridges of the other part, upon coupling thereof.

Another simple and inexpensive embodiment, as shown in Figs. 17 and 18 provides, in combination with the rigid cup-shaped element 3, in lieu of a diaphragm 2 to be simply secured to the rigid cup-shaped element 3 with or without a ring nut 11 or bushing, an element 82 made of an elastomeric material, also having a cup shape, and which has appropriate thicker portions along its side walls, for contacting the inner surface of the side walls of the rigid cup-shaped element 3, the rigid cup-shaped element 3 being axially deeper than the elastomeric cup-shaped element 82.

The extensible plastic element 82, which is preferably made by injection molding and has the shape of a cup, has a thicker and stiffer peripheral rim.

Similarly to the variant described with reference to the bushing 11 or ring nut for securing the diaphragm 2 against the rigid cup-shaped element 3, the free edge of the extensible plastic cup-shaped element 82 has a stiffening flange or annular widened portion of any suitable shape, and made of the same material, whose inside diameter preferably corresponds to the inside diameter of the capsule 3 or cup-shaped element minus twice the thickness of the cylindrical portion of

the element 82, whereas the outside diameter is equal to or greater than the outside diameter of the capsule 3 or rigid cup-shaped element, and its thickness is sufficient to stiffen the edge.

The above embodiments are described with reference to both cylindrical or substantially cylindrical and conical or substantially conical rigid cup-shaped elements or capsules.

The above variant embodiments are also provided for both plastic and metal capsules 3 or rigid cup-shaped elements.

As will be more apparent hereafter, some of the embodiments find a more appropriate application for truncated cone-shaped capsules 3 or rigid cup-shaped elements and others to cylindrical rigid cup-shaped elements 3.

Referring to a first embodiment, when this is provided in combination with caps formed by rigid cup-shaped elements 3, i.e. rigid metal capsules, the invention proposes a process for making such combinations of capsules and diaphragms 2 including the steps of:

1. Grasping and firmly holding the rigid cup-shaped element 3 from the side opposite to the open side to be closed by the diaphragm 2, preferably by using an electromagnet 37 which comes in contact with the rigid cup-shaped element 3 from the outside of the closed side thereof;

2. Pushing the rigid cup-shaped element 3 into a cylindrical hole having an appropriate diameter, along

the axis of said rigid cup-shaped element 3 and/or of the cylindrical hole, an extensible plastic diaphragm 2 having been previously subtended over the opening of said hole, in any suitable manner.

3. Stretching the diaphragm, through the interposition of the rigid cup-shaped element 3, by penetration thereof in the cylindrical hole or by passage through the cylindrical hole, so that the surface of the diaphragm, due to its internal transverse stresses, will take the shape of a paraboloid of revolution, against an appropriately positioned annular blade 38, which annular blade 38 is situated at a certain distance from the hole opening and behind it with respect to the direction in which the rigid cup-shaped element 3 is pushed onto the diaphragm 2, which annular blade 38 is overhanging and integral with the inside of the hole, whose diameter is greater than the outside diameter of the rigid cup-shaped element 3 and obviously smaller than that of the cylindrical hole.

Hence, the diaphragm 2 is cut along a circular line, thereby forming a peripheral band which will overlap the truncated cone-shaped outer wall of the rigid cup-shaped element 3 thanks by shrinking thereon.

Therefore, the peripheral band of the diaphragm 2 shrinks around the truncated cone-shaped wall of the rigid cup-shaped element 3, its diameter becoming smaller than the greatest diameter of said rigid cup-shaped element 3, due to the internal transverse resilient stresses generated by longitudinal stretching

of the extensible plastic polymer.

Once more, this can be obtained in combination with rigid cup-shaped elements 3 having either a cylindrical or a truncated cone shape.

The processes for fabricating the combination diaphragm 2 and rigid cup-shaped element 3 form the subject of the dependent claims and are described in detail in the following description of the preferred embodiments.

Regarding the methods of fitting the closure device according to the present invention, after combination of the extensible diaphragm 2, either in the form of a diaphragm 2 previously fitted on the rigid cup-shaped element 3, or in the form of an extensible plastic cup-shaped element 82, the device of the invention is fitted on the opening of the container 1 in a usual and known manner.

In thread-on closure devices, particularly for plastic bottles, the rigid cup-shaped element that forms the capsule is mounted by elastic force fitting of the cap onto the container, with an axial displacement relative to the axis of the closure device and/or the container opening, whereby the diaphragm 2 cannot be broken before or during coupling of the closure device. In this axial force fitting step, the natural resiliency of the extensible cup-shaped element 82 and of the container 1 allow mutual coupling of the cooperating threads of said two parts and of the engagement means of the tamperproof ring, thanks to the action of compression means.

When the closure device is fitted on the container 1 (with well-known methods used for non-composite capsules, unlike the capsule of this invention) the opening of the bottle or any other container, exerts a force on the diaphragm 2 or the extensible plastic cup-shaped element 82 thereby causing it to stretch thereon, in such a manner that the diaphragm adheres against the edge of the opening of the container 1, and a sealing action is effect which is independent of the cap tightening force. When the cap of the container 1 is opened, e.g. unscrewed, the diaphragm is subjected to shearing stresses is broken, thereby permanently indicating the opened condition. Thus, the closure device of the invention allows to readily check if the container has been tampered. In fact, even though the use of well-known techniques for disengagement of the tamperproof ring from the ridges 35 that hold it against the opening of the bottle 1 allow to prevent the separation thereof from the cap, no final opening of the container might occur without damaging the diaphragm subtended over the container opening, for instance for fraudulent attempts to replace the product contained therein.

Further improvements and variants of the invention will form the subject of the subclaims.

Referring to Figure 1, a closure device is composed of a composite capsule, consisting of a rigid cylindrical cup-shaped element 3 and an extensible plastic diaphragm 2 that is subtended over the whole opening of the cup-shaped element 3, i.e. secured to

the delimiting edge of the open side of the cup-shaped element 3.

Advantageously, in order to provide a larger adhesion surface, said edge of the side wall of the cup-shaped element 3 surrounding the opening is arranged to be radially widened in the form of a flange. The diaphragm 2 may be secured to the rigid cup-shaped element 3 in any manner, e.g. by gluing, welding or other chemical and/or physical adhesion arrangements.

Fig. 3 shows a variant of the embodiment of Fig. 1, in which the peripheral flange for attachment of the diaphragm 2 has an outwardly divergent conical profile with slightly arched surfaces for diaphragm adhesion.

Such embodiment is advantageous for the elastic force fitting arrangement, which is possible thanks to the natural resilience of the diaphragm 2, when said diaphragm is fitted on the opening of the rigid cup-shaped element 3 by pressing the latter against the diaphragm and subsequently cutting the diaphragm 2 along a circular line surrounding the rigid cup-shaped element 3 at a certain radial distance therefrom, as shown in the process described in claim 33.

Thanks to the use of an extensible material, after the cutting step, the peripheral band of the diaphragm 2 is subjected to an elastic shrinking effect, which causes the peripheral flange to shrink against the conical flange. If this band has a sufficient width, the outermost radial portion may reach the annular groove and form, by shrinking, a sort of collar around

the rigid cup-shaped element 3.

However, in the embodiment of Figure 2, the diaphragm is embedded within the rigid cup-shaped element 3. This embodiment is advantageous in that the stretched embedded diaphragm is less exposed to direct contact and hence to contamination and mechanical damages.

Once again, the extensible diaphragm has a peripheral flange, but the latter is designed to be secured in a position in which it overlaps the inner side of the peripheral walls of the cylindrical rigid cup-shaped element 3.

Like in the previous example of Figure 1, the diaphragm may be attached by gluing, welding or any other well-known chemical and/or physical adhesion arrangement.

Figures 4 and 5 show two alternative embodiments wherein the diaphragm 2 is secured in an intermediate position between the open side and the closed side of the rigid cup-shaped element 3.

In both cases, the rigid cup-shaped element 3 is provided in combination with a ring nut or a bushing 11, 13, which is designed to engage in the rigid cup-shaped element 3, e.g. by crimping or elastic force fitting.

In the example of Figure 4, the ring nut or bushing 11 has an inside diameter that is substantially equal to or slightly greater than the outside diameter of the cup-shaped element 3 and is designed to lie coaxially over the cylindrical wall thereof, at least

over a portion having a predetermined axial extension, i.e. a partial or full extension of the cylindrical wall of the rigid cup-shaped element 3. The diaphragm 2 is subtended over the opening of the rigid cup-shaped element 3 and a peripheral flange thereof overlaps the outer side of the peripheral cylindrical wall of said cup-shaped element 3. Therefore, the diaphragm is mechanically retained between the outer side of the cylindrical wall of the rigid cup-shaped element 3 and the ring nut or bushing 11 wherein said rigid cup-shaped element 3 is fitted. If the rigid cup-shaped element 3 and the bushing or ring nut 13 are made from metal, the two parts may be coupled by crimping or by radially pressing the bushing or ring nut 12 against the cylindrical wall of the rigid cup-shaped element 3 and this may occur before or during application of the closure device to the container, which application includes rolling of the closing device on the opening of the container to form, for instance, the outside threads and the mutual engagement tabs between the closure device and ridges, annular shoulders and/or recesses of the container opening, as is currently used for application of metal capsules to close containers, such as bottles or the like.

If the rigid cup-shaped element 3 and the ring nut or bushing 11 or 13 are made of plastic, then the two parts may be connected by elastic and/or snap fitting and/or by welding and/or gluing or other chemical and/or physical adhesion arrangements, possibly combined with a previous snap or elastic force fitting

coupling. Possibly, the free edge of the opening of the rigid cup-shaped element 3 may be slightly rounded or may slightly shrink, in a conical profile, to facilitate insertion thereof in the bushing or ring nut 11.

The variant embodiment of Figure 5 discloses an inverse situation, in which the bushing 13 or ring nut 11 is designed to be inserted in the rigid cup-shaped element 3, the diameters of said two parts being appropriately sized therefor. In this case, the diaphragm 2 is subtended over the end of the bushing 13 or ring nut 11 to be disposed inside the rigid cup-shaped element 3. The diaphragm is attached to the bushing or ring nut 11, and the bushing or ring nut 11 is coupled to the rigid cup-shaped element 3 substantially as described regarding the previous embodiment of Fig. 4.

Figure 6 shows a variant embodiment in which a disk-like seal 4 or the like is provided in addition to the diaphragm 2 of the embodiment of Figure 2.

In Figure 7, the closed wall of the rigid cup-shaped element 3 has an aperture 9 which is outwardly closed by a transparent wall 8, sealed to said aperture 9, for instance glued on the inner side of the corresponding wall of the rigid cup-shaped element 3, and may even consist of a sealing ring.

Figure 3 bis shows a variant of the embodiment of Figure 2, wherein, along a predetermined axial portion of the cylindrical wall of the rigid cup-shaped element 3 or possibly of the inner ring nut 11, the cylindrical

peripheral wall of the rigid cup-shaped element 3 is discontinuous, i.e. formed by wall portions separated by notches 12. Nevertheless, the invention shall not be intended to be limited to this condition, which only embodies a process for facilitating the application of the diaphragm 2.

Figures 14 or 15 or 16 show an exemplified method of fitting of the closure device to a bottle 1. The principle of using a diaphragm to seal the surfaces of containers 1 is substantially the same for any embodiment described herein.

When the closure device is fitted on the opening of the container 1, this device is axially pushed over the opening of the container 1, which exerts pressure on the diaphragm and extends it. In these conditions, the diaphragm is stretched. While the elastomer that forms the diaphragm has plastic properties, i.e. mutually sliding macromolecules, it is also capable of partly recovering its original structure, by partial resilience, after being stretched. Particularly, when a diaphragm 2 made of such a polymer is laid over an opening of a container 1 and is simultaneously stretched axially along the opening, for example by fitting the composite capsule therein, the volume of its material decreases in sections coaxial to the opening, as these sections approach the opening of the container 1. A surface of revolution is thereby generated, whose generatrix is a paraboloid.

As soon as the longitudinal stresses in the plastic material are released, the resilient features,

that are higher along the axes perpendicular to vertical stretching, due to geometric and mechanical reasons, cause an annular shrinking effect parallel to the concentric cross sections of the surface of revolution, thereby causing the diaphragm 2 to crimp the outer edge of the opening. This shrinking or crimping effect may achieve very high pressure values, depending on the thickness of the diaphragm 2, but is always effective to ensure a tight sealing effect.

At the same time, the diaphragm 2 may be advantageously fitted on the rigid capsule 3 by heating the diaphragm 2 and the rigid capsule 3 and the opening of the container 1. In fact, heating causes changes in the technical properties of plastic materials to facilitate adhesion thereof.

The composite capsule of this invention may be alternatively used with an elastic seal 4. This seal 4 is typically positioned, for hygienic and sealing purposes, between the cap 3 and the diaphragm 2. It is also typically fitted directly inside the capsule 3.

In Figures 14, 15 and particularly 16, the rigid cup-shaped element 3, also known as capsule, consists of a screw cap, including a tamperproof sealing ring, which is connected to the rest of the cup-shaped element 3, i.e. the actual screw cap by a tear-off line, requiring a predetermined breaking force.

If the cup-shaped element is made from metal, its threads, the predetermined tear-off line of the sealing ring 36 and any further deformations of the rigid cup-shaped element 3 required to ensure coupling thereof to

the opening of the bottle 1 are obtained in a well-known manner, thanks to a shaping process which consists in outside rolling of the cup-shaped element against the opening of the bottle 1, the latter having ridges that form the external threads 101 and annular shoulders 35 for axially retaining the sealing ring, that is designated by numeral 36.

Then, the closure device is fitted on the opening and pushed against it until the edge of the opening of the container 1 abuts against the corresponding wall of the rigid cup-shaped element 3, which thereby deforms the diaphragm 2 to obtain the above described effects.

Figures 14a, 15a and 16a show the condition prior to pushing the device against the opening of the bottle 1, whereas Figs. 14b, 15b, and 16b show non realistic removal of the screw cap part, in which the predetermined tear-off line 33 and the bridges that retained the tamperproof ring are visible.

The diaphragm 2 is shown in an unbroken condition, even though it is necessarily torn off by the unscrewing operation. Therefore, any attempt the unscrew the closure device without breaking the tamperproof ring 32, e.g. by using tools for allowing the ring 32 to pass over the ridges 201, causes the diaphragm 2 subtended over the opening of the bottle 1 to be forcibly broken, to faultlessly indicate that the bottle was opened.

In this connection, advantages may be obtained from providing a transparent wall 8 like in the variant of Figure 7. By this arrangement, any damage to the

diaphragm 2 is readily visible, without opening the container.

Figures 16a and 16b show the above with reference to the variants of Figures 4 and 5.

In this case, the diaphragm 2 operates in exactly the same manner, and a few details of the tamperproof ring 32 are only changed, without affecting the features and the operating modes thereof.

Several different processes are provided for making a device as shown in Figure 2. A first process is shown in Fig. 26 and may be possibly also implemented for rigid cup-shaped elements 3 made of plastic, the process providing that a diaphragm disk 2, whose diameter is greater than the inside diameter of the capsule 3 is first made to coaxially adhere by vacuum 20 to the closed, suitably perforated bottom of a hollow cylinder 21 whose inside diameter is smaller than the inside diameter of the capsule or rigid cup-shaped element 3 to be later forced into the capsule 3 and caused to adhere thereto, by the 90° bent portion of the diaphragm disk 2, which exceeds the diameter of the cylinder 21, along a cylindrical portion, next to the free edge of the rigid cup-shaped element 3. A low taper truncated cone may be provided instead of a cylinder, with the bottom having a smaller diameter.

Another apparatus for implementing the above process, as shown in Fig. 27, consists of a modular cylinder, i.e. composed of several parts, whose outside diameter is smaller than the inside diameter of the rigid cup-shaped element 3, said modular cylinder being

longitudinally divided into at least two sectors 27 which have a 180° angular width, are perforated and equal, have a closed bottom and may be transversely spread apart by pneumatic cam actuators, e.g. by pistons 28 and cylinders 28bis appropriately disposed between the sectors 27 or by inflatable bags, whereas they may be drawn closer by suitable springs 29, e.g. annular springs that outwardly and inwardly surround the sectors 27 of the modular cylinder. Each hollow sector 27 of the cylinder is maintained under vacuum 20 and has at least one hole in its closed bottom. Mechanical drive means accomplish the operations of grasping the diaphragm disk 2, introducing it in the capsule 3 and then pressing the portion thereof that exceeds the diameter of the cylinder 21 against the inner cylindrical portion of the capsule 3, provided for adhesion.

A variant of the process for fitting the diaphragm 4 is shown in Figures 8 to 13. Here, the open side of the rigid cup-shaped element 3 is first flared by a conical wedge 14 and later flattened by a flat head cylinder 15, whereas the rigid cup-shaped element 3 is accommodated in a correspondingly shaped housing 16, and a diaphragm disk 2 is laid on the plane of the portion that is bent at 90° with respect to the cylinder axis, in any suitable manner. Then, the flattened edge, with the diaphragm 2 fitted thereon is brought back to its original position by a first bend back step, and subsequently straightened by rolling it by appropriate rollers 17 and counter rollers 18 and/or

by a coaxial compression of conical sectors 19, which are connected to form a sort of mandrel, while the capsule 3 is firmly held in its seat or receptacle 16 by applying vacuum thereto.

The steps of flaring, flattening, fitting the diaphragm disk 2 and subsequently restoring the position of the bent portion may be also carried out on the rectangular or trapezoidal surfaces delimited by the cuts 12, as shown in Fig. 3 bis, on which the diaphragm 2 adheres.

Also, flaring or 90° flattening of the free edge of the rigid cup-shaped element 3 may be obtained by spin molding the rigid cup-shaped element 3 from ductile metal. Here a metal pellet is introduced in an appropriate openable mold and forced by spinning to spread through the whole space in the mold, the above mentioned straightening steps being carried out later on.

However, referring to Figures 17 and 18, the latter show a variant embodiment, relating to claim 12 and other claims dependent therefrom, wherein the diaphragm 2 is replaced by a cup-shaped element 82 made of an extensible material, which has an enlarged peripheral edge at its opening, and is coupled to the rigid cup-shaped element 3 by being force fitted therein or by force fitting the enlarged portions against the peripheral wall of the rigid cup-shaped element 3, thereby obtaining a deformation 84 of said peripheral wall, i.e. the formation of recesses for engagement of said thickened edge 85, shaped by the

extensible plastic cup-shaped element 82.

The diaphragm of the cup-shaped element 82 is formed by its closed side and its peripheral wall whereas, as described above, the thickened edge is used for coupling with the rigid cup-shaped element 3 thanks to a mutual complementary shaping which forms cooperating snap fitting means.

When considering the rigid cup-shaped element 3 in greater detail, the diaphragm 2 is replaced by an extensible plastic element 82, preferably made by injection molding, and having the shape of a cup with a thicker or stiffer peripheral rim, i.e. having the shape of a closed bottom hollow cylinder with an appropriate thickness, whereas its free edge has a flange or an annular stiffening enlarged portion, of any shape and made of the same material, the inside diameter of such flange or enlarged portion being preferably equal to the inside diameter of the rigid cup-shaped element 3, minus twice the thickness of the cylindrical portion of the element, whereas the outside diameter is equal to or greater than the outside diameter of the rigid cup-shaped element 3 and its thickness is sufficient to stiffen the rim.

Such extensible plastic cup-shaped element 82 is fitted in the rigid cup-shaped element 3, in such a manner that the thickened rim thereof comes in contact with the free edge of the rigid cup-shaped element 3, whereas its cylindrical wall and its closed bottom act as a thin diaphragm to be stretched as the device is fitted on the opening of the container 1. The outer

closed cylindrical portion of this element 82 is shorter than the inner cylindrical portion of the rigid cup-shaped element 3 and is in contact therewith.

The extensible plastic cup-shaped element 82 may be integrated with the rigid cup-shaped element 3, either by the simple elastic response of its stiffened rim against the free edge of the capsule 3 or by gluing or melting a part or all of its surface in contact with the rigid cup-shaped element 3. The extensible plastic element 82 may further have the shape of a closed-bottom truncated cone, which is closed on the smaller diameter side, and is preferably provided in combination with rigid truncated cone-shaped cup-like elements 8.

The stiffened, enlarged rim 85 and/or the flange may form a tamperproof seal to be preferably held in the special annular housing of the rigid cup-shaped element 3 or in any other appropriate manner.

Figures 19 and 20 show a process and an apparatus for fabricating composite capsules according to the invention, which have a truncated-cone shape and are combined with a sealing film or diaphragm 2.

The process for making a truncated-cone shaped metal composite capsule, adhering to the rigid capsule by shrinking thereon, includes the steps of:

Firmly holding the rigid cup-shaped element 3 from the side opposite to the open side to be closed by the diaphragm 2, preferably by using an electromagnet 37 which comes in contact with the rigid cup-shaped element 3 from the outside of the closed side thereof;

2. Introducing the rigid cup-shaped element 3 in a cylindrical hole having a suitable diameter along the axis of said rigid cup-shaped element 3 and/or of the cylindrical hole.

3. Subtending an extensible plastic diaphragm 2 over the opening of said hole, and retaining it therein, in any suitable manner.

4. Stretching the diaphragm 2 with the help of the rigid cup-shaped element 3 upon penetration thereof in the cylindrical hole, which diaphragm will take, due to its internal transverse stresses, the shape of a paraboloid of revolution.

5. After pushing the rigid cup-shaped element 3 onto the diaphragm 2, cutting the diaphragm 2 all around the rigid cup-shaped element 3, for instance by using a sharp annular blade 38, placed at a certain distance from the hole and behind it. Said annular blade 38 projects coaxially and integrally into the cylindrical hole and its diameter is greater than the outside diameter of the rigid cup-shaped element 3 and obviously smaller than that of the cylindrical hole.

Due to the transverse resilient stresses caused by longitudinal stretching of the extensible plastic polymer, the edge cut from the diaphragm shrinks around the outer surface of the free edge of the rigid cup-shaped element 3, its diameter becoming smaller than the greatest diameter of the truncated cone-shaped rigid cup-shaped element 3, and is finally locked in position by crimping.

The information below applies to all caps in

accordance with this specification:

The composite capsule, which essentially consists of a rigid cup-shaped element 3, wherein the extensible diaphragm 2 is subtended perpendicular to the axis of the rigid cup-shaped element 3, and whose plane is at a suitable distance between the open side and the bottom of said rigid cup-shaped element 3, must fulfill a few particular conditions.

The first condition is that it shall be able to be used in experimental or currently available capping apparatus.

The second condition is that the diaphragm 2 may be properly stretched on the opening edge of bottles 1 or similar containers by a single operation, i.e. by pressing the rigid cup-shaped element 3 against the opening of the bottle 1 or similar container, and that, after this stretching step, when the opening of the container 1 comes in contact with the bottom of the rigid cup-shaped element 3, the latter may be crimped or molten, if it is made of plastic, by using conventional apparatus, on the opening of the container 1. This operation allows to achieve a strong and tight elastic closure.

The third condition is that such composite capsules shall be easily sterilizable both for storage and immediately before capping.

Further, this composite capsule shall also have particular geometric and mechanical properties, the most important whereof is the distance of the pre-applied diaphragm 2 from the opening edge of the rigid

cup-shaped element 3, depending on the quality and thickness of the extensible plastic polymer as well as on the shape and quality of the metal or plastic material that forms the rigid element 3.

These basic properties are:

1. The diaphragm 2 must be situated at such a distance from the opening of the rigid cup-shaped element 3 that the composite capsule may loosely cap the opening of the container 1 to be sealed.

2. The distance between the diaphragm 2 and the bottom of the rigid cup-shaped element 3 must be such that, as said rigid cup-shaped element 3 is pressed against the opening of the container 1, the diaphragm 2 is sufficiently stretched to firmly adhere against the edge of the container 1, but not to such an extent as to be torn thereby.

The materials that form the capsule must be capable of firm adhesion by crimping, by other elastic arrangements, by heating or melting or by screwing thereof to the opening of the container.

In order to obtain these characteristics, the invention also provides processes to make preassembled capsules out of a ductile metal, capable of being crimped.

According to a variant embodiment of the invention as shown in Figures 22, 23, 24, 25, the cap described herein may have additional seal or tamperproof means which consist of an extension 30 of the wall of the cap, i.e. the rigid cup-shaped element 3 toward the bottom of the container 1, i.e. toward the opposite

side of the container 1, which extension starts from the portion of the rigid cup-shaped element 3 adjacent to the predetermined tear-off or breaking line 33, which separates the cap part from the sealing ring 36, and extends beyond said sealing ring to cover the whole of it. In this case, the extension is provided as a conical widened part, designed to lie over the whole seal ring, which is held between two continuous or discontinuous annular shoulders 35, or designed to lie over a continuous or discontinuous annular shoulder 36 on the rear side with respect to the cap removal direction, which shoulder/s are formed on the neck of the container or bottle 1 at a predetermined distance from the opening thereof.

The conical extension is made of a rigid material and effectively prevents the sealing ring from being deformed by any tool, in an attempt to pass it over the annular shoulder 35, by removing the whole capsule without separating the sealing ring 36 from the cap part, to conceal tampering.

Advantageously, as is shown in Figures 22, 23, 24 and 25, the conical extension of the rigid cup-shaped element 3 which forms the cap part extends beyond the sealing ring 36 toward the bottom of the bottle or container, thereby forming a sort of drinking glass of any shape whatever, whose wall lies over the peripheral skirt wall of the bottle or container at least in the free edge portion of the extension, or at least along an end strip next to said free edge, or substantially all along the wall of said extension. Different

alternatives may be provided depending on the shape of the bottle or container.

Advantageously, said extension may be made of one piece with the cap part of the rigid cup-shaped element 3 or is glued or welded thereon whereby said cap part of the rigid cup-shaped element 3 forms the drinking glass bottom.

Advantageously, in order to ensure that the glass is sufficiently hygienic, the glass has such an axial length and such a shape as to ensure that the free edge of the glass and a portion adjacent thereto are placed in such a position relative to the bottle 1 or the container, that the label 32 overlaps said free edge and said portion to protect the free edge of the drinking glass and a peripheral portion adjacent thereto, while preventing contaminating particles from penetrating the glass.

Figures 22, 23, 24 and 25 show different embodiments of this arrangement.

In Figure 22, the bottom 34 of the glass also forms the cap bottom, transverse to the axis of the bottle, said cap element and the glass 30 being made from one piece. It shall be noted that said wall transverse to the axis of the bottle 1 is thicker and has a diameter that is greater than that of the cap bottom. This provides a solid support base for the drinking glass portion formed by the extension 30, and further facilitates unscrewing and removal of the cap from the bottle 1.

In the embodiment of Figure 23, the glass-like

extension 30 has a seat 130 in which the cap part of the rigid cup-shaped element 3 is secured by gluing and/or welding and/or any other chemical and/or physical method. In this case the seat, whose shape is complementary to the outer shape of the rigid cup-shaped element 3, is formed inside the outer peripheral wall of the glass-like extension 30.

The variant of Figure 25 shows a different construction in which the glass-like extension is still a glass separated from the cap part, but the seat for attachment of the glass-like element 30 consists of an appropriately sized narrowed portion of the peripheral wall of the glass-shaped element 30, whereas an outer hood- or cup-shaped closure element 39 is provided, which closes the peripheral wall of the glass element 30 at its end situated on the closed side of the cap part 3.

According to a variant embodiment as shown in Figure 21 the drinking glass has a shape that substantially corresponds to that of the end of the bottle 1 or container, and is associated to the bottom thereof, said drinking glass 31 having such a size and/or shape as to be readily removably secured to said bottom end of the bottle by elastic force fitting. Here again, the label 32 is arranged to overlap the free edge of the glass with the same effect as in the previous embodiment.

This embodiment may be provided in combination with the previous embodiment, whereby a bottle may be associated with at least two drinking glasses, one of

which is also used to protect the sealing ring 36.

KEY:

The characteristics of the invention will appear more clearly from the following description of a non-limiting embodiment, which is shown in the annexed drawings, in which:

Fig. 1 is an axial sectional view of a cylindrical closure device according to a first embodiment of the invention.

Figure 2 shows, like Figure 1, a variant of the embodiment that is shown therein.

Figure 3 is a view of an additional variant of the embodiment as shown in Fig. 1.

Fig. 3 bis is yet another view of a different variant embodiment according to claim 40.

Figs. 8 to 13 show different steps of a process for making a metal closure device according to the invention.

figs. 14a and 14b show the method of fitting the device as shown in Fig. 2 on a bottle.

figs. 15a and 15b show, like Fig. 14, a method of fitting the device as shown in Fig. 5 on a bottle.

figs. 16a and 16b show, like Fig. 14, a method of fitting the device as shown in Fig. 4 on a bottle.

Figs. 17 and 18 show the elements according to claim 13 and dependent claims, and the arrangement thereof.

Figs. 19 and 20 show the apparatus according to claim 33 for making a truncated cone-shaped metal closure device in accordance with this invention in two

different operating steps.

Fig. 21 is a view of a container, associated to a drinking glass that mates the shape of its bottom.

Figs. 22, 23, 24 show a different embodiment of the closure device according to the invention, in which the rigid cup-shaped element is coupled to a drinking glass-like extension that covers the tamperproof sealing ring, and a drinking glass that mates the bottom of the container.

Fig. 26 is a sectional view of the perforated cylinder as it holds by vacuum a diaphragm disk to be fitted in the capsule.

Fig. 27 shows a cylinder divided into two sectors, that may be spread apart to fit a diaphragm disk in the capsule.